Cancer Mortality Patterns Among Hairdressers and Barbers in 24 US States, 1984 to 1995

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We evaluated cancer mortality patterns among hairdressers and barbers, according to occupation, coded on 7.2 million death certificates in 24 states from 1984 to 1995. Of the 38,721 deaths among white and black hairdressers and barbers of both sexes, 9495 were from all malignant neoplasms. Mortality odds ratios were significantly elevated for all malignant neoplasms, lung cancer, and all lymphatic and hemopoietic cancers among black and white female hairdressers. White female hairdressers had significant excess mortality from cancers of the stomach, colon, pancreas, breast, and bladder and from non-Hodgkin's lymphoma and lymphoid leukemia; mortality from these cancers was also elevated among black female hairdressers. White male hairdressers had significantly elevated mortality from non-melanoma skin cancer and non-Hodgkin's lymphoma. Mortality from all malignant neoplasms, although significantly elevated among both white and black female hairdressers, was significantly below the null for white male hairdressers. Black and white male barbers had significantly elevated mortality from stomach and pharyngeal cancer, respectively. A significant deficit in mortality from all neoplasms and cancers of the pancreas, lung, and prostate was noted for white male barbers. This large study of cancer mortality among hairdressers and barbers showed some differences in mortality patterns by gender and race. Further studies are required to determine if specific occupational exposures may explain some of the elevated cancer rates. (J Occup Environ Med. *2001;43:250–258*)

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Hairdressers and barbers represent a large occupational group with frequent exposures to products that are mutagens and carcinogens. The terms hairdresser, cosmetologist, and beautician seem to be used interchangeably. Of the 500,000 to 750,000 professional cosmetologists and hairdressers in the United States, about 80% to 85% are women.[1] Apart from using nail- and skin-care products, these professionals work with a number of hair preparations, such as bleaches, shampoos, conditioners, hair dyes, hair sprays, and waving and straightening preparations. Together, these formulations contain several thousand chemicals. In general, barbers are male, cut only men's hair, and have limited exposure to hair dyes and other cosmetic products. The products used by hairdressers and cosmetologists are, with a few exceptions, similar to the retail products sold for home use. Thus, the potential exposure for consumers, either in beauty salons or at home, would be to a similar range of chemical substances as for hairdressers but with differences in the frequency and duration of exposure.

Studies of occupational exposures among hairdressers have focused on hair dyes for several reasons. In the 1970s, a number of the aromatic amines and related nitro compounds in permanent hair dyes were found to be mutagens and animal carcinogens.[2,3] It was previously determined that these compounds could be absorbed through the skin,[4] and urinary mutagens were later found in the urine of cosmetologists.[5] Several epidemiologic cohort studies of female hairdressers found increased risks of many cancers, most notably non-Hodgkin's lymphoma (NHL) and ovarian cancer.[6–10] Personal use of hair dyes, particularly of permanent dark dyes,[11,12] was also associated with an elevated risk of NHL in several studies[11–14] but not in others.[15–17] A recent study found higher NHL death rates only for prolonged use (10 or more years) of black or brown dyes.[18] The use of permanent dark hair dyes has also been associated with an elevated risk of leukemia.[19]

The epidemiologic evidence for cancer among male hairdressers and barbers is limited to a consistent excess of bladder cancer found in five large cohort studies.[7,20–23] Although these studies did not adjust for smoking, two[7,21] found excesses of bladder cancer that were not accompanied by appreciable excesses of lung cancer. Overall, most published cohort studies of occupational exposure in hairdressers have been limited to examining cancers of the breast, bladder, lung, ovary, and lymphatic and hemopoietic cancers. Because of their relatively small size, these studies have not had sufficient power to evaluate less common cancers.

Because a number of studies have found increased cancer risks for hairdressers and barbers, we investigated cancer mortality among these occupational groups by examining more than 38,000 death certificates from 24 US states over 12 years.

Methods

The National Cancer Institute, the National Institute for Occupational Safety and Health, and the National Center for Health Statistics have supported the coding of usual occupation and industry titles[24] on death certificates from 24 states since 1984. This coding of industry and occupation on death certificates serves as a tool for the national surveillance of occupational disease. We used 7.2 million death certificates from these 24 states to evaluate mortality patterns among hairdressers and cosmetologists (hereafter called hairdressers) and barbers. Our analysis included 38,721 deaths in 24 states among hairdressers (Standard Occupation Code 458) and barbers (Code 457), 20 years of age and older, from 1984 to 1995. Of the 38,721 deaths under Codes 458 and 457, a total of 9495 were due to all-malignant neoplasms. We did not include Alaska because mortality records from that state were available only for 1 year, with fewer than 2000 deaths reported. Ethnic groups other than whites and blacks were also excluded because of small numbers.

Mortality odds ratios (MORs) and 95% confidence intervals (CIs) were calculated according to Miettinen and Wang[25] separately for male and female hairdressers and for male barbers. The number of total cancer and non-cancer deaths (n = 400) among female barbers was too low to calculate cancer MORs. All non-cancer deaths were used as the referent group. The MORs were stratified by race and gender. Age-specific (20 to 39, 40 to 59, 60 to 74, and 75+ years) MORs were calculated when numbers permitted. The analyses were also performed separately for five regions of the country: eastern (Maine, New Hampshire, New Jersey, Rhode Island, Vermont), north central (Indiana, Ohio, Wisconsin), south central (Kansas, Oklahoma, Missouri, Nebraska), southern (Kentucky, Georgia, North Carolina, South Carolina, Tennessee, West Virginia), and western (Colorado, Idaho, Nevada, New Mexico, Utah, Washington). We evaluated the overall mortality for all cancers combined and for specific cancer sites but reported MORs for cancer sites only if there were five or more deaths in one of the gender/race groups.

Results

Among the hairdressers, there were 26,617 cancer and non-cancer deaths: 19,980 white women, 3602 black women, 2641 white men, and 394 black men. Mortality from all malignant neoplasms combined was significantly elevated among female hairdressers of both races (n = 6510) (Table 1). There was a significant deficit in mortality from all malignant neoplasms for white male hairdressers (n = 375), and for black men it was lower than expected (n = 39). Among female hairdressers, mortality from cancer was significantly elevated among whites for the following sites: stomach, colon, pancreas, lung, breast, and bladder. Mortality from all lymphatic and hemopoietic cancers, NHL, leukemia/aleukemia, and lymphoid leukemia was also significantly elevated for white women. Mortality from the same cancers was also elevated among black women, with significant elevations for lung cancer and all lymphatic and hemopoietic cancers. Both white and black female hairdressers had elevated mortality from cancers of the digestive organs and peritoneum, kidney, and brain and from multiple myeloma and myeloid leukemia. Elevations in mortality for nasopharyngeal and pharyngeal cancers and cancers of the larynx, connective tissue, skin (non-melanoma), and Hodgkin's disease were also observed among white female hairdressers. Mortality from cancers of the pharynx, liver, cervix, uterus, and ovary was elevated among black women. Non-significant deficits in mortality among female hairdressers occurred for cancers of the esophagus and bone and joints. Black female hairdressers had mortality deficits for cancers of lip/salivary gland/buccal cavity, and connective tissue.

White male hairdressers had significantly elevated mortality from non-melanoma skin cancer and NHL. Among black men, with the exception of all lymphatic and hemopoietic cancers, all other sites with elevations in mortality accounted for four or fewer deaths. Significant deficits in mortality were observed among white men for cancers of the

TABLE 1
MORs Among Hairdressers by Race and Gender for Select Cancer Sites*

	White Women			Black Women			White Men			Black Men		
Cancer Site	MOR	n[†]	CI	MOR	n[†]	CI	MOR	n[†]	CI	MOR	n[†]	CI
All malignant neoplasms	1.13	5,643	1.10–1.17	1.15	867	1.06–1.24	0.71	375	0.64–0.79	0.81	39	0.59–1.12
Lip, salivary glands, buccal cavity	1.06	33	0.75–1.48	0.60	3	0.20–1.84	0.72	4	0.27–1.89	0.00	0.963[‡]	
Nasopharynx	1.30	6	0.59–2.90	1.23	1	0.18–8.52	0.91	1	0.13–6.39	0.00	0.181[‡]	
Pharynx	1.36	24	0.91–2.03	1.23	5	0.51–2.94	0.46	2	0.12–1.83	0.00	1.044[‡]	
Digestive organs, peritoneum	1.11	1,221	1.05–1.18	1.10	234	0.97–1.26	0.66	76	0.52–0.83	0.64	8	0.33–1.24
Esophagus	0.92	38	0.67–1.27	0.63	10	0.34–1.17	0.54	7	0.26–1.12	0.00	2.505[‡]	
Stomach	1.21	114	1.01–1.45	1.11	29	0.77–1.60	0.47	7	0.23–0.99	0.00	2.053[‡]	
Colon	1.12	561	1.03–1.22	1.18	103	0.97–1.43	0.46	20	0.30–0.72	0.58	2	0.16–2.04
Rectum	0.95	66	0.75–1.21	1.20	13	0.70–2.06	1.11	9	0.58–2.13	5.00	4	2.04–12.26
Liver	0.87	18	0.54–1.37	1.68	7	0.80–3.52	1.86	8	0.94–3.69	0.00	0.803[‡]	
Pancreas	1.24	312	1.11–1.39	1.01	51	0.77–1.34	0.75	17	0.47–1.21	0.52	1	0.08–3.35
Larynx	1.36	21	0.89–2.08	0.66	2	0.17–2.62	0.42	2	0.11–1.64	0.00	0.853[‡]	
Trachea, bronchus, lung	1.32	1,413	1.25–1.40	1.26	162	1.07–1.47	0.71	114	0.59–0.86	0.84	12	0.48–1.47
Bone and joints	0.63	6	0.28–1.39	0.70	1	0.10–4.92	0.40	1	0.06–2.84	0.00	0.213[‡]	
Connective tissue	1.06	39	0.78–1.46	0.89	6	0.40–1.97	0.31	2	0.08–1.22	1.71	1	0.25–11.85
Melanoma	0.98	63	0.76–1.25	0.50	1	0.07–3.51	0.44	9	0.23–0.85	12.85	1	2.21–68.12
Skin (non-melanoma and NOS)	1.27	16	0.78–2.07	1.22	2	0.31–4.86	2.92	11	1.62–5.25	2.72	1	0.39–18.74
Breast	1.10	1,027	1.03–1.17	1.15	153	0.98–1.36	0.00	0.636[‡]		13.10	1	2.38–72.22
Cervix uteri	0.91	93	0.74–1.12	1.10	32	0.78–1.55		–		–		
Corpus uteri, uterus NOS, chorionepithelioma	0.89	108	0.73–1.07	1.12	33	0.79–1.57		–		–		
Ovary, fallopian tubes	1.00	285	0.89–1.12	1.22	37	0.89–1.69		–		–		
Prostate		–		–			0.80	27	0.54–1.17	0.53	2	0.14–2.01
Testis		–		–			0.46	2	0.12–1.84	0.00	0.143[‡]	
Bladder, urethra, other urinary organs	1.36	88	1.10–1.68	1.19	15	0.72–1.98	0.59	6	0.27–1.31	0.00	0.482[‡]	
Kidney, renal pelvis	1.08	91	0.88–1.33	1.15	12	0.66–2.03	0.36	5	0.15–0.85	0.86	1	0.14–5.22
Brain	1.09	132	0.91–1.29	1.29	10	0.70–2.39	0.41	11	0.23–0.74	0.00	1.037[‡]	
Thyroid	0.58	7	0.27–1.21	0.98	2	0.25–3.91	1.07	1	0.15–7.48	0.00	0.041[‡]	
All lymphatic and hemopoietic cancer	1.15	569	1.15–1.25	1.31	84	1.05–1.62	0.99	70	0.78–1.25	1.05	6	0.49–2.22
Non-Hodgkin's lymphoma	1.15	227	1.01–1.31	1.13	17	0.70–1.81	1.49	43	1.10–2.01	0.47	1	0.08–2.83
Hodgkin's disease	1.38	23	0.92–2.08	2.40	4	0.91–6.33	0.92	6	0.41–2.05	1.76	1	0.26–11.68
Multiple myeloma	1.18	102	0.97–1.43	1.20	30	0.84–1.72	0.98	7	0.47–2.05	3.18	3	1.07–9.40
Leukemia, aleukemia	1.15	200	1.00–1.32	1.29	26	0.88–1.90	0.42	11	0.23–0.75	0.50	1	0.10–2.51
Lymphoid leukemia	1.32	59	1.02–1.71	1.43	8	0.71–2.85	0.62	4	0.24–1.65	0.00	0.436[‡]	
Myeloid leukemia	1.07	83	0.86–1.32	1.34	12	0.76–2.35	0.54	7	0.26–1.12	0.98	1	0.20–4.86
Monocytic leukemia	0.39	1	0.05–2.77	0.00	0.291[‡]		0.00	0.354[‡]		0.00	0.022[‡]	

* MOR, mortality odds ratio; CI, 95% confidence interval; NOS, not otherwise specified.
[†] Number of deaths.
[‡] Number of expected deaths when number of observed deaths was zero.

stomach, colon, lung, skin (melanoma), kidney, and brain and for leukemia/aleukemia. Non-significant decreases in mortality were observed in white men for cancers of the pancreas, prostate, bladder, and from Hodgkin's disease, multiple myeloma, and myeloid leukemia.

An analysis of the cancer mortality patterns of hairdressers by geographic region (data not shown) revealed excess mortality from all cancers among white women in every region, which was significant in the eastern (MOR, 1.29; 95% CI, 1.18 to 1.42), north central (MOR, 1.21; 95% CI, 1.14 to 1.28), south central (MOR, 1.11; 95% CI, 1.01 to 1.21), and southern (MOR, 1.08; 95% CI, 1.01 to 1.14) regions of the country. Among black women, overall mortality was elevated in every area except the western region, with significant elevation in the north central states (MOR, 1.37; 95% CI, 1.19 to 1.59).

Among white female hairdressers, elevations in mortality in all five regions were seen for pancreatic cancer, lung cancer, all lymphatic and hemopoietic cancers, multiple myeloma, leukemia and aleukemia, and lymphoid leukemia. Elevations in mortality from cancer at other sites were scattered over the five regions. For black women, no single cancer site presented elevated mortality in all of the five regions. A significant elevation in mortality from all cancers combined generally occurred among white women 40 years of age and older and among black women 60 years of age and older. White women age 40 and older had elevated mortality from cancers of the stomach, colon, and ovary. Among black women, mortality at these sites was elevated only for women age 60 and older.

Among white male hairdressers, the deficit of mortality from all can-

TABLE 2
MORs Among Barbers by Race for Select Cancer Sites*

Cancer Site	White Men MOR	White Men n†	White Men CI	Black Men MOR	Black Men n†	Black Men CI
All malignant neoplasms	0.93	2,198	0.88–0.97	0.99	373	0.88–1.12
Lip, salivary glands, buccal cavity	0.84	18	0.53–1.34	0.67	3	0.22–2.05
Nasopharynx	0.38	1	0.05–2.67	1.56	1	0.22–10.92
Pharynx	0.60	10	0.32–1.11	1.92	10	1.04–3.58
Digestive organs, peritoneum	0.93	509	0.85–1.02	0.95	88	0.76–1.18
Esophagus	0.91	48	0.69–1.21	0.47	8	0.24–0.94
Stomach	1.26	81	1.01–1.57	0.76	12	0.43–1.34
Colon	0.95	216	0.83–1.08	1.14	33	0.81–1.61
Rectum	0.72	27	0.50–1.06	1.02	5	0.43–2.44
Liver	1.02	17	0.63–1.64	1.55	5	0.65–1.71
Pancreas	0.78	81	0.62–0.96	1.07	18	0.68–1.71
Larynx	0.69	16	0.42–1.12	0.87	5	0.37–2.07
Trachea, bronchus, lung	0.90	700	0.83–0.98	0.88	105	0.71–1.07
Bone and joints	1.82	7	0.87–3.82	1.57	1	0.22–10.91
Connective tissue	0.94	11	0.52–1.69	2.13	3	0.69–6.56
Melanoma	0.68	22	0.45–1.04	0.00	0.506‡	
Skin (non-melanoma and NOS)	0.86	12	0.49–1.51	2.50	4	0.96–6.51
Breast	0.38	1	0.05–2.69	0.00	0.487‡	
Prostate	0.86	288	0.77–0.97	1.11	80	0.88–1.39
Testis	0.62	1	0.09–4.40	0.00	0.157‡	
Bladder, urethra, other urinary organs	0.98	75	0.78–1.23	1.48	9	0.77–2.5
Kidney, renal pelvis	0.98	52	0.74–1.28	1.14	7	0.55–2.39
Brain	1.17	53	0.89–1.53	1.28	4	0.48–3.39
Thyroid	1.54	5	0.64–3.69	0.00	0.298‡	
All lymphatic and hemopoietic cancer	1.02	233	0.89–1.16	1.08	28	0.74–1.56
Non-Hodgkin's lymphoma	0.88	72	0.70–1.11	0.79	5	0.33–1.87
Hodgkin's disease	0.85	5	0.35–2.04	0.00	0.728‡	
Multiple myeloma	1.24	49	0.94–1.64	1.23	11	0.68–2.22
Leukemia, aleukemia	1.09	97	0.89–1.33	1.10	10	0.59–2.04
Lymphoid leukemia	1.00	29	0.69–1.43	0.34	1	0.05–2.33
Myeloid leukemia	1.16	39	0.85–1.58	1.1	4	0.42–2.94
Monocytic leukemia	0.00	1.244‡		0.00	0.090‡	

* For definition of abbreviations, see Table 1.
† Number of deaths.
‡ Number of expected deaths when number of observed deaths was zero.

cers combined was consistent across all regions (data not shown). Among black male hairdressers, mortality deficits for all cancers combined were observed in all areas except the southern and western states. Mortality from all malignant neoplasms combined was lower than expected for white men under age 75 and for black men younger than 60. With the exception of the south central states, NHL was elevated in all states and in all ages below 75 for white men. NHL was significantly elevated among the youngest white men, ages 20 to 39 (MOR, 2.11; 95% CI, 1.38 to 3.21). For black male hairdressers, all regional and age group specific estimates for individual cancer sites were based on fewer than five deaths.

For male barbers, 11,704 cancer and non-cancer deaths occurred from 1984 to 1995. Of those, 10,172 occurred in white men and 1532 in black men. Overall cancer mortality was slightly lower than expected for white barbers (n = 2198) and very close to expected for black barbers (n = 373). Mortality among white male barbers and black male barbers was significantly elevated for stomach and pharyngeal cancers, respectively (Table 2). Among barbers of both races, MORs were elevated for multiple myeloma and leukemia/aleukemia. Mortality from specific cancers among barbers differed somewhat from that among male hairdressers.

There were significant mortality deficits for all malignant neoplasms among white male barbers, and with the exception of the eastern states, these deficits occurred in all regions. An overall significant deficit in mortality was also noted for cancers of the pancreas, lung, and prostate among white barbers, but mortality from pancreatic and prostate cancer in the north central region and lung cancer in the south central region was slightly elevated. Black male barbers had a significant deficit in mortality for esophageal cancer. Mortality from cancer of the lip/salivary glands/buccal cavity, digestive organs, larynx, and NHL was lower than expected for both races. A significant excess of mortality from cancer of the bladder occurred only among white male barbers in the eastern (MOR, 1.69; 95% CI, 1.09 to 2.62) and south central (MOR, 1.76; 95% CI, 1.11 to 2.80) regions. No discernible patterns in mortality according to age were observed for the male barbers.

Discussion and Conclusions

We observed significant increases in mortality from cancers of the lung and all lymphatic and hemopoietic cancers among female hairdressers of both races in the 24 states. For white female hairdressers, significant mortality also occurred from cancer of the stomach, colon, pancreas, breast, and bladder and from NHL, leukemia/aleukemia, and lymphoid leukemia. The increases in risk, however, were not very large. There was a statistically significant deficit among white male hairdressers for mortality from all malignant neoplasms and cancers of the stomach, colon, lung, melanoma, kidney, and brain and from leukemia/aleukemia, whereas mortality from non-melanoma skin cancer and NHL was significantly elevated.

White male barbers also had a significant deficit of mortality from all malignant neoplasms and from cancers of the pancreas, lung, and prostate. In contrast to white male hairdressers, white male barbers did not exhibit elevated mortality from rectal cancer, non-melanoma skin cancer, or NHL. Mortality from stomach cancer and pharyngeal cancer was significantly elevated among white and black barbers, respectively, and mortality from multiple myeloma and leukemia/aleukemia was elevated among both white and black barbers.

In our analysis, female hairdressers had significantly elevated mortality from all malignant neoplasms, for which male hairdressers and barbers had an overall mortality deficit. This deficit in mortality from all malignant neoplasms was significant among white male hairdressers and barbers. A significant elevation in mortality from colon and lung cancer was noted in female hairdressers but not in male hairdressers. Among white hairdressers, mortality from cancers of the stomach, pancreas, and bladder and from lymphoid leukemia was significantly elevated only for the women. Mortality from cancers of the pharynx, stomach, pancreas, lung, bladder, kidney, and brain, including almost all of the lymphatic and hemopoietic cancers, was elevated among female hairdressers of both races but not among the men.

The difference noted in mortality between male and female hairdressers could be because of differences in gender-based exposure and susceptibility to workplace toxins. Anatomic and physiologic differences between the sexes can influence metabolism, as can cardiovascular, pulmonary, gastrointestinal, and renal structure and function. This can result in variations in exposures, target tissue doses, metabolism of toxicants, and, consequently, in different responses of the sexes to workplace and environmental chemicals.[26]

A previous analysis of cancer mortality among cosmetologists in Connecticut found excess cancer mortality among women,[9] but most cohort studies in other countries have not observed excess cancers overall.[8,10,20,21] Previous epidemiologic studies of hairdressers and barbers in Europe, United States, and Japan have found elevated rates of various cancers, with excesses for bladder, lung, ovarian, and lymphatic and hemopoietic cancers reported most frequently.[27] We noted excess mortality from cancers of the bladder and lung and from lymphatic and hemopoietic cancers among female hairdressers of both races, but ovarian cancer was elevated only among black female hairdressers. Male hairdressers and barbers also had excess mortality from specific lymphatic and hemopoietic cancers.

We observed elevated pharyngeal cancer mortality among female hairdressers and male barbers. An excess of buccal cavity and pharyngeal cancer has been noted in the past only among male hairdressers[21]; another study from the United Kingdom failed to find an increased risk for these sites.[20] Excessive alcohol consumption has been shown to increase the risk of developing cancers of the mouth and pharynx.[28,29] Female cosmetologists were one of the occupational groups with the highest standard mortality rates for cirrhosis of the liver in one study.[30] However, a lack of information on alcohol consumption trends among hairdressers precludes an association between excessive alcohol intake and the observed elevation in mortality from pharyngeal cancer. We observed a significant increase in stomach cancer mortality among white female hairdressers and white male barbers. A significant excess of stomach cancer among Japanese female beauticians[10] and an excess of stomach cancer among female hairdressers[13,31] were noted previously. Socioeconomic status is also known to influence health status. Hairdressers and barbers have been placed in the "secondary blue collar" category in previous sociological research, which is indicative of the lowest socioeconomic status.[32] Cancers of the pharynx and stomach have been associated with lower socioeconomic status,[33] lower education level, and smoking.[34]

In the current study, we found a significant elevation in mortality from cancer of the lung for female hairdressers. A significant elevation in lung cancer mortality among female hairdressers was noted previously,[35] and elevated rates of lung cancer were consistently observed in cohort studies of female hairdressers,[8,9,10,22,23] with few exceptions.[7] Both formaldehyde, used in shampoos and nail products, and vinyl chloride, previously used as a propellant in hair-spray compounds, have been associated with lung cancer in some occupational studies. However, the epidemiologic data are not strong or consistent.[36] A more probable explanation for this observed excess of lung cancer may be a higher prevalence of smoking among hairdressers, as was noted in Sweden[22,23] and in the United States.[37] Another US study[38] found no association between lung cancer and specific occupational tasks or exposures of female hairdressers after controlling for smoking status.

Our results show an excess of pancreatic cancer mortality among female hairdressers and black male barbers. Hairdressers are exposed to solvents from hair- and nail-care products and to aromatic amines from hair dyes; exposure to the latter has also been linked with high rates of pancreatic cancer.[39] Pancreatic cancer is clinically associated with pancreatitis, which in turn has been associated with occupational exposure to organic solvents.[40] Nonsignificant elevations in the risk for pancreatic cancer have been found for male barbers in Massachusetts[41–43] and for male hairdressers in Finland.[8] Smoking increases the risk of pancreatic cancer severalfold and has been consistently associated with pancreatic cancer.[44–50] However, specific etiologic agents for pancreatic cancer have not been identified.[40]

Mortality due to non-melanoma skin cancer was elevated in our analysis for white female hairdressers, and significantly so for white male hairdressers. An increased risk for non-melanoma skin cancer was observed in the past among female hairdressers in a Finnish cohort study.[8]

We observed significantly elevated mortality from breast cancer in white female hairdressers and a nonsignificant elevation for black women. Evidence of excess breast cancer risk among hairdressers has been inconsistent in studies conducted in the past. A significant excess of breast cancer in female cosmetologists was noted in the United States[9] and Japan,[28] with a nonsignificant excess noted in other US[51] and Finnish[8] studies. A review of occupational studies on female breast cancer found limited evidence of an association with employment as a cosmetologist,[52] but a recent study found an excess risk for breast cancer for Swedish hairdressers and beauticians.[53] Excess breast cancer was also reported in New York[54] and Washington state[55] among women who made personal use of hair dyes. However, six case-control studies[51,56–60] and one cohort study[15] found no significant excess of breast cancer among hair dye users.

Occupational exposure to aromatic amines may explain up to 25% of bladder cancers in some areas of Western countries.[61] The excess rates of bladder cancer among hairdressers has been of particular interest because of their frequent exposure to hair-coloring products that contain mutagens and possible bladder carcinogens.[27,62] Urine mutagenicity was increased in hairdressers who were exposed to hair dyes compared with those having no such exposure,[5] suggesting that the dye components are absorbed systemically.

In our analysis, female hairdressers and black male barbers experienced excess mortality from bladder cancer. Excess bladder cancer incidence and mortality have been observed in previous studies[7,9,21,22] but not consistently,[63] especially among women.[8,10,23] The results from numerous case-control studies of bladder cancer that evaluated occupation as a barber or hairdresser are not consistent and were usually limited by small numbers.[27] Overall, allowance for smoking was lacking or inadequate in most studies. The largest study, a population-based case-control study in 10 areas of the United States, found a 30% increased risk among white male barbers and hairdressers and a 40% increased risk among white female hairdressers.[64] A recent Canadian case-control study found a strongly increased risk of bladder cancer for hairdressers[65]; all of the three cases among hairdressers involved application of hair dyes.

We found excess mortality from brain cancer in female hairdressers and white male barbers; however, there was a significant deficit of this cancer among white male hairdressers. Teta et al found an excess of brain cancer among male and female cosmetologists in Connecticut.[9] A significant excess of brain cancer was noted among hairdressers in Missouri[66] and among adults using hair dye or hair spray in Canada.[67]

We observed excess mortality from all lymphatic and hemopoietic cancers among all hairdressers and barbers, although the specific cancer varied according to gender and profession. NHL-related mortality was elevated among female hairdressers and white male hairdressers. Mortality from Hodgkin's disease, multiple myeloma, leukemia/aleukemia, and lymphoid and myeloid leukemia was also elevated among female hairdressers. Barbers had excess mortality from multiple myeloma, leukemia/aleukemia, and myeloid leukemia. Most studies have found elevated risks of NHL or all lymphoma[68,69] or other lymphopoietic cancers[9,10,21,70–72] among hairdressers. For the most part, these studies were conducted in Europe and included white women. A significant excess for NHL among female hairdressers was found in Australia[6] and Denmark,[69] but the risk of NHL was decreased in Sweden.[69] A nonsignificant excess of NHL was noted among male and female hairdressers in Denmark,[7] among male hairdressers in the United States,[73] and for female hairdressers in Italy.[74,75]

The overall incidence of NHL has risen steadily over the past four decades.[76] NHL and Kaposi's sarcoma are AIDS-defining illnesses,[77] and infection with the human immunodeficiency virus is most strongly correlated with increasing incidence of NHL in the United States.[78] The increased acquired immunodeficiency syndrome mortality rates observed for male hairdressers[79] and better diagnosis of NHL might partly explain the excess mortality from NHL observed in male and female hairdressers. However, HIV-associated disease accounts for only a small part of the increase in this form of lymphoma.[76] Another explanation may be hairdressers' exposure to solvents in hair- and nail-care products. In a review of 45 studies on the possible association between NHL and exposure to organic solvents, 13 defined or suggested organic solvents as possible risk factors for NHL.[80]

A non-significant excess for Hodgkin's disease for female hairdressers was noted in other studies[31,74,75,81] and in our analysis. A case-control study of personal exposure to hair dyes[11] found an increased risk of Hodgkin's disease in women who used hair dyes; the risk was higher for use of permanent hair dyes.

An excess of multiple myeloma among hairdressers was observed in the United States,[13,71] Europe,[74,75,82] and Australia,[6] with a sixfold increase for female hairdressers reported in one study.[70] In a study from Finland,[8] no excess for multiple myeloma was observed for female hairdressers. Among barbers, an excess of multiple myeloma was found in the United States,[83] and a significant increase was reported in Canada.[84] In the United States, a significant elevation in risk for multiple myeloma was noted among male hair dye users[85] and among women who use dark permanent hair dyes,[11] especially black permanent hair dye.[18]

Studies of Italian hairdressers found a sixfold increase in the risk for chronic myeloid leukemia[19] and an excess risk for lymphocytic leukemia.[75] A significant association between acute lymphocytic leukemia and hair dye use was found in the United States,[14,86] and a slightly increased risk was noted in one Italian study[75] for women who use permanent hair dyes.

The major advantage of the data we used is the large numbers of deaths, which allowed us to compare mortality patterns among both male and female hairdressers and barbers by race, age, and geographic regions across the country. However, the small number of deaths for many of the cancer sites limited age- and region-based comparisons in mortality. The limitations of an analysis that uses coding of occupation on death certificates to define exposure include the questionable accuracy of the coding of occupation and some causes of death. There is the potential for misclassification errors, which would tend to bias risk estimates toward the null.[87] The accuracy of coding for cause of death is quite good for cancers of the stomach, pancreas, lung, prostate, and thyroid and for multiple myeloma, but not as good for cancers of the colon, rectum, connective tissue, bone, and cervix.[88]

Another limitation of this analysis was the lack of detailed information on occupation and industry and on confounding lifestyle factors such as smoking, diet, and HIV infection status. Although death certificates require the "usual" or lifetime occupation and industry of the deceased, the information entered may be more representative of occupation or industry at the time of death.[89] Also, death certificates do not provide information on other occupations held by the deceased in the past, so duration of exposure and latency cannot be analyzed.

In our MOR analysis, all non-cancer deaths were used as the reference group. A major limitation of MOR analyses is their dependence on non-cancer mortality rates, of which cardiovascular deaths are a major component. Caution should be used in the interpretation of MOR analyses because the patterns observed may be due to differences in mortality from cardiovascular or other diseases across groups.

The International Agency for Research on Cancer has concluded that occupation as a hairdresser or barber entails exposures that are probably carcinogenic.[27] Our results showed excess mortality from many cancers among these groups that are generally consistent with cancer excesses reported in the literature, especially among female hairdressers. Male hairdressers and barbers had deficits of cancer overall and at many sites; however, mortality from certain lymphatic and hemopoietic cancers was elevated. Although the observed excesses in mortality might be attributed to the various chemicals and chemical mixtures that hairdressers and barbers are exposed to occupationally, the effects of lifestyle risk factors for cancer-related mortality such as alcohol consumption, smoking, sexual habits, and low socioeconomic status cannot be ignored. Synergistic effects between chemical exposures and lifestyle factors may also lead to increased risk.

For hairdressers, current exposure to hair dye components differs from that in the past. Over the past 20 years, many of the chemicals discovered to be mutagenic and carcinogenic in hair dyes and other hair preparations have been banned from use in the United States and Europe. Nevertheless, commercially used hair dyes still contain many carcinogenic compounds. Substitutes used by hair dye manufacturers might also be potentially carcinogenic because, chemically, they are close structural relatives of the banned chemicals.

The effects of exposure to chemical mixtures on hairdressers and barbers are by and large unknown, and the availability of human data for such exposures is limited. Further detailed studies that emphasize exposure assessment in hairdressing salons and barbershops are required. Apart from ascertaining the duration and frequency of exposure, such studies should focus on occupational exposure to specific products such as hair dyes, hair sprays, nail treatments, and so forth in hairdressing salons to tease out the individual effects of different products and chemicals.

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